Estimating Vegetation Parameters from Interferometric and Polarimetric Radar Using Physical Scattering Models

Robert N. Treuhaft
Jet Propulsion Laboratory, California Institute of Technology
4800 Oak Grove Drive, 138-212
Pasadena, CA USA
Ph. 818-354-6216 Fax: 818-393-5115 email: rnt@radar-sci.jpl.nasa.gov

Background

Radar data from vegetated land surfaces depend on many structural and compositional parameters describing the terrain. Because early, noninterferometric radar systems usually constituted an insufficient observation set from which to estimate parameters of the terrain, statistical regression techniques were used which incorporated some level of apriori knowledge or field measurements. With the advent of radar interferometry and polarimetric interferometry, potentially at multiple baselines, the observation set is now approaching that required to quantitatively estimate the parameters describing a vegetated land surface. Quantitative estimation entails formulating a physical scattering model relating the radar observations to the vegetation and surface parameters on which they depend. This paper describes the physics of candidate scattering models, and shows how the models determine the estimable parameter set. It also indicates the measurement accuracy of parameters such as vegetation height, height-to-base-of-live-crown, and surface topography with multibaseline polarimetric interferometry. SAR interferometry

Physical Scattering Models: Balancing Simplicity and Realism

vegetation structure

Initial demonstrations of parameter-estimation approaches to radar interferometry and polarimetry rely on very simple models of forested terrain [1,2]. Because the observation set in these demonstrations is one- or two-baseline interferometry plus the polarimetric power ratio, HHHH/VVVV, constituting at most 5 observations, the number of estimated parameters must be equivalently small. This means that models must describe simple scattering mechanisms which depend on a small number of parameters. This paper describes the physics of these first-generation models, involving randomly oriented volumes over horizontal surfaces, and shows that vegetation height, extinction coefficient, surface topography, and one to two parameters describing the ground can be estimated. The extended observation set entailed by fully polarimetric interferometry at many baselines enables the use of more realistic models. This paper will show that fully polarimetric multibaseline interferometry will prompt models involving layered, oriented vegetation over sloped ground surfaces with a corresponding increase in the number of parameters. Candidate parameter sets will be described.

Demonstrations

Vegetation parameters such as tree height and underlying topography estimated from multibaseline interferometric and polarimetric data collected with JPL AIRSAR/TOPSAR will be described. Parameter estimate accuracies from data will be compared to those expected from observation errors.

Reference

[1] R. N. Treuhaft *et al*, Radio Science, vol. 31, pp. 1449-1485, 1996.

[2] R. N. Treuhaft and P. R. Siquiera, Radio Science, in review, 1999.